**Stable isotope dynamics (δ13C and δ15N) in neritic and oceanic waters of the North Atlantic inferred from GPS-tracked Cory’s shearwaters**

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**SUPPLEMENTARY TABLES**

**Supplementary Table 1.** Relationships (Spearman’s correlation) between response (underlined) and explanatory variables used in the random forest model for the pooled data of the 191 Cory’s shearwaters (*Calonectris borealis*) from Berlenga and Corvo Islands, between 2010 and 2015. Upper right cells correspond to the Spearman R value, and the lower left cells correspond to p values (\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; n.s. non-significant). Significant results (R values) are also in italics. See Table 1 for a description of each explanatory variable.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **δ13C** | **δ15N** | **NAO** | **wNAO** | **Lat** | **Long** | **D\_Colony** | **Depth** | **SST** | **Chl a** | **D\_Coast** | **D\_ICoast** |
| **δ13C** | - | *0.44* | *0.24* | *0.17* | -0.04 | *-0.56* | *-0.35* | *-0.42* | *-0.38* | *0.59* | *-0.42* | *-0.57* |
| **δ15N** | \*\*\* | - | -0.05 | *-0.25* | *0.23* | *-0.21* | *-0.23* | *-0.29* | 0.13 | 0.13 | *-0.28* | *-0.19* |
| **NAO** | \*\* | n.s. | - | *0.61* | *-0.45* | *-0.53* | *-0.19* | *-0.29* | *-0.38* | *0.42* | *-0.26* | *-0.51* |
| **wNAO** | \* | \*\*\* | \*\*\* | - | *-0.27* | *-0.31* | -0.05 | *-0.18* | *-0.19* | *0.31* | -0.13 | *-0.31* |
| **Lat** | n.s. | \*\* | \*\*\* | \*\*\* | - | *0.39* | 0.02 | 0.05 | *0.48* | *-0.32* | *0.19* | *0.44* |
| **Long** | \*\*\* | \*\* | \*\*\* | \*\*\* | \*\*\* | - | *0.61* | *0.76* | *0.45* | *-0.82* | *0.79* | *0.96* |
| **D\_Colony** | \*\*\* | \*\* | \*\* | n.s. | n.s. | \*\*\* | - | *0.78* | *0.18* | *-0.55* | *0.84* | *0.62* |
| **Depth** | \*\*\* | \*\*\* | \*\*\* | \* | n.s. | \*\*\* | \*\*\* | - | 0.12 | *-0.71* | *0.90* | *0.78* |
| **SST** | \*\*\* | n.s. | \*\*\* | \*\* | \*\*\* | \*\*\* | \* | n.s. | - | *-0.57* | 0.14 | *0.47* |
| **Chl a** | \*\*\* | n.s. | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | - | *-0.67* | *-0.84* |
| **D\_Coast** | \*\*\* | \*\*\* | \*\*\* | n.s. | \*\* | \*\*\* | \*\*\* | \*\*\* | n.s. | \*\*\* | - | *0.82* |
| **D\_ICoast** | \*\*\* | \* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | - |

**Supplementary Table 2.** Relationships (Spearman’s correlation) between response (underlined) and explanatory variables used in the random forest model for the neritic environment of the 142 Cory’s shearwaters (*Calonectris borealis*) from Berlenga Island, between 2010 and 2015. Upper right cells correspond to the Spearman R value, and the lower left cells correspond to p values (\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; n.s. non-significant). Significant results (R values) are also in italics. See Table 1 for a description of each explanatory variable.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **δ13C** | **δ15N** | **NAO** | **wNAO** | **Lat** | **Long** | **D\_Colony** | **Depth** | **SST** | **Chl a** | **D\_ICoast** | **D\_River** | **D\_Canyon** |
| **δ13C** | - | *0.70* | -0.06 | *-0.22* | *0.36* | *-0.50* | *-0.46* | *-0.39* | -0.09 | *0.46* | *-0.49* | *-0.29* | *-0.43* |
| **δ15N** | \*\*\* | - | 0.12 | -0.15 | *0.32* | *-0.45* | *-0.31* | *-0.38* | 0.04 | *0.35* | *-0.40* | *-0.30* | *-0.24* |
| **NAO** | n.s. | n.s. | - | *0.52* | 0.01 | -0.12 | -0.05 | *-0.17* | *0.25* | -0.04 | -0.08 | -0.16 | -0.05 |
| **wNAO** | \*\* | n.s. | \*\*\* | - | -0.04 | -0.05 | 0.01 | -0.12 | *0.33* | -0.03 | -0.05 | -0.12 | -0.01 |
| **Lat** | \*\*\* | \*\*\* | n.s. | n.s. | - | *-0.36* | *-0.45* | *-0.30* | 0.01 | *0.25* | *-0.24* | -0.04 | *-0.55* |
| **Long** | \*\*\* | \*\*\* | n.s. | n.s. | \*\*\* | - | *0.69* | *0.85* | -0.15 | *-0.76* | *0.92* | *0.75* | *0.65* |
| **D\_Colony** | \*\*\* | \*\*\* | n.s. | n.s. | \*\*\* | \*\*\* | - | *0.69* | 0.15 | *-0.67* | *0.74* | *0.44* | *0.92* |
| **Depth** | \*\*\* | \*\*\* | \* | n.s. | \*\*\* | \*\*\* | \*\*\* | - | -0.12 | *-0.76* | *0.89* | *0.72* | *0.61* |
| **SST** | n.s. | n.s. | \*\* | \*\*\* | n.s. | n.s. | n.s. | n.s. | - | -0.13 | -0.10 | *-0.27* | 0.12 |
| **Chl a** | \*\*\* | \*\*\* | n.s. | n.s. | \*\* | \*\*\* | \*\*\* | \*\*\* | n.s. | - | *-0.79* | *-0.68* | *-0.58* |
| **D\_ICoast** | \*\*\* | \*\*\* | n.s. | n.s. | \*\* | \*\*\* | \*\*\* | \*\*\* | n.s. | \*\*\* | - | *0.76* | *0.63* |
| **D\_River** | \*\*\* | \*\*\* | n.s. | n.s. | n.s. | \*\*\* | \*\*\* | \*\*\* | \*\* | \*\*\* | \*\*\* | - | *0.37* |
| **D\_Canyon** | \*\*\* | \*\* | n.s. | n.s. | \*\*\* | \*\*\* | \*\*\* | \*\*\* | n.s. | \*\*\* | \*\*\* | \*\*\* | - |

**Supplementary Table 3.** Relationships (Spearman’s correlation) between response (underlined) and explanatory variables used in the random forest model for the oceanic environment of the 49 Cory’s shearwaters (*Calonectris borealis*) from Corvo Island, in 2010 and 2015. Upper right cells correspond to the Spearman R value, and the lower left cells correspond to p values (\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; n.s. non-significant). Significant results (R values) are also in italics. See Table 1 for a description of each explanatory variable.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **δ13C** | **δ15N** | **NAO** | **wNAO** | **Lat** | **Long** | **D\_Colony** | **Depth** | **SST** | **Chl a** | **D\_Coast** | **D\_ICoast** |
| **δ13C** | - | -0.20 | *0.64* | *0.43* | *0.77* | *0.52* | *0.76* | *0.69* | *-0.73* | *0.76* | *0.76* | 0.27 |
| **δ15N** | n.s. | - | *-0.64* | *-0.32* | -0.11 | -0.12 | -0.16 | -0.12 | 0.22 | -0.23 | -0.19 | -0.20 |
| **NAO** | \*\*\* | \*\*\* | - | *0.67* | *0.41* | *0.39* | *0.43* | *0.37* | *-0.57* | *0.57* | *0.44* | *0.34* |
| **wNAO** | \*\* | \* | \*\*\* | - | 0.16 | 0.27 | 0.18 | 0.12 | -0.24 | 0.23 | 0.17 | *0.28* |
| **Lat** | \*\*\* | n.s. | \*\* | n.s. | - | *0.39* | *0.97* | *0.88* | *-0.73* | *0.86* | *0.97* | 0.07 |
| **Long** | \*\*\* | n.s. | \*\* | n.s. | \*\* | - | *0.43* | *0.60* | *-0.50* | *0.54* | *0.43* | *0.88* |
| **D\_Colony** | \*\*\* | n.s. | \*\* | n.s. | \*\*\* | \*\* | - | *0.91* | *-0.76* | *0.84* | *0.99* | 0.13 |
| **Depth** | \*\*\* | n.s. | \*\* | n.s. | \*\*\* | \*\*\* | \*\*\* | - | *-0.73* | *0.79* | *0.91* | *0.32* |
| **SST** | \*\*\* | n.s. | \*\*\* | n.s. | \*\*\* | \*\*\* | \*\*\* | \*\*\* | - | *-0.70* | *-0.75* | -0.24 |
| **Chl a** | \*\*\* | n.s. | \*\*\* | n.s. | \*\*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | - | *0.85* | 0.26 |
| **D\_Coast** | \*\*\* | n.s. | \*\* | n.s. | \*\*\* | \*\* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | - | 0.14 |
| **D\_ICoast** | n.s. | n.s. | \* | \* | n.s. | \*\*\* | n.s. | \* | n.s. | n.s. | n.s. | - |

**Supplementary Table 4.** Relationships (Spearman’s correlation) between response (underlined) and explanatory variables used in the random forest model for the neritic environment at a local scale (i.e. <100 km from the colony) of the 90 Cory’s shearwaters (*Calonectris borealis*) from Berlenga Island, between 2010 and 2015. Upper right cells correspond to the Spearman R value, and the lower left cells correspond to p values (\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; n.s. non-significant). Significant results (R values) are also in italics. See Table 1 for a description of each explanatory variable.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **δ13C** | **δ15N** | **NAO** | **wNAO** | **Lat** | **Long** | **D\_Colony** | **Depth** | **SST** | **Chl a** | **D\_ICoast** | **D\_River** | **D\_Canyon** |
| **δ13C** | - | *0.74* | -0.18 | *-0.48* | *0.26* | *-0.34* | *-0.34* | -0.17 | *-0.32* | *0.37* | *-0.34* | 0.12 | *-0.21* |
| **δ15N** | \*\*\* | - | 0.03 | *-0.38* | 0.09 | *-0.42* | *-0.28* | *-0.34* | -0.11 | *0.31* | *-0.42* | -0.08 | -0.04 |
| **NAO** | n.s. | n.s. | - | *0.45* | -0.20 | 0.03 | 0.06 | -0.07 | *0.50* | *-0.28* | -0.01 | -0.19 | 0.12 |
| **wNAO** | \*\*\* | \*\*\* | \*\*\* | - | -0.16 | -0.01 | 0.15 | -0.06 | *0.43* | -0.13 | 0.01 | *-0.22* | 0.09 |
| **Lat** | \* | n.s. | n.s. | n.s. | - | -0.17 | *-0.63* | 0.13 | *-0.27* | -0.20 | 0.10 | *0.84* | *-0.91* |
| **Long** | \*\* | \*\*\* | n.s. | n.s. | n.s. | - | *0.30* | *0.70* | -0.11 | *-0.54* | *0.86* | 0.19 | 0.03 |
| **D\_Colony** | \*\* | \*\* | n.s. | n.s. | \*\*\* | \*\* | - | 0.17 | *0.31* | -0.08 | *0.23* | *-0.57* | *0.71* |
| **Depth** | n.s. | \*\* | n.s. | n.s. | n.s. | \*\*\* | n.s. | - | -0.18 | *-0.49* | *0.76* | *0.30* | -0.14 |
| **SST** | \*\* | n.s. | \*\*\* | \*\*\* | \* | n.s. | \*\* | n.s. | - | -0.16 | -0.10 | *-0.37* | *0.27* |
| **Chl a** | \*\*\* | \*\* | \*\* | n.s. | n.s. | \*\*\* | n.s. | \*\*\* | n.s. | - | *-0.55* | *-0.32* | *0.22* |
| **D\_ICoast** | \*\* | \*\*\* | n.s. | n.s. | n.s. | \*\*\* | \* | \*\*\* | n.s. | \*\*\* | - | *0.32* | -0.15 |
| **D\_River** | n.s. | n.s. | n.s. | \* | \*\*\* | n.s. | \*\*\* | \*\* | \*\*\* | \*\* | \*\* | - | *-0.87* |
| **D\_Canyon** | \* | n.s. | n.s. | n.s. | \*\*\* | n.s. | \*\*\* | n.s. | \*\* | \* | n.s. | \*\*\* | - |

**Supplementary Table 5.** Mixed-effects ANOVA model for the effect of explanatory variables in δ13C and δ15N values, for the pooled data of the 191 Cory’s shearwaters (*Calonectris borealis*) from Berlenga and Corvo Islands, between 2010 and 2015. Bold terms indicate statistically significant effects. See Table 1 for a description of each explanatory variable. Note that some variables were log10 or log10+1 transformed to better fit the assumptions of the model (normally distributed variables and homoscedastic residuals).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | δ13C values | | δ15N values | |
|  | F | p | F | p |
| NAO | 22.46 | **<0.001** | 0.58 | 0.446 |
| wNAO | 6.21 | **0.014** | 74.82 | **<0.001** |
| Lat (Log10) | 0.97 | 0.326 | 18.91 | **<0.001** |
| Long (Log10) | 141.90 | **<0.001** | 9.74 | **0.002** |
| D\_Colony (Log10) | 4.40 | **0.037** | 15.40 | **<0.001** |
| Depth (Log10) | 8.17 | **0.005** | 25.43 | **<0.001** |
| SST (Log10) | 23.36 | **<0.001** | 1.01 | 0.318 |
| Chl a (Log10+1) | 10.24 | **0.002** | 3.29 | 0.072 |
| D\_Coast (Log10+1) | 0.02 | 0.893 | 1.82 | 0.179 |
| D\_ICoast (Log10+1) | 8.51 | **0.004** | 0.01 | 0.913 |
| Year | 10.05 | **<0.001** | 16.88 | **<0.001** |
| Stage | 2.59 | 0.078 | 3.05 | 0.050 |
| Month | 31.23 | **<0.001** | 23.21 | **<0.001** |
| Island | 0.10 | 0.755 | 2.53 | 0.113 |

**Supplementary Table 6.** Mixed-effects ANOVA model for the effect of explanatory variables in δ13C and δ15N values, for the 142 Cory’s shearwaters (*Calonectris borealis*) from Berlenga Island, between 2010 and 2015. Bold terms indicate statistically significant effects. See Table 1 for a description of each explanatory variable. Note that some variables were log10 or log10+1 transformed to better fit the assumptions of the model (normally distributed variables and homoscedastic residuals).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | δ13C values | | δ15N values | |
|  | F | p | F | p |
| NAO | 1.09 | 0.298 | 7.06 | **0.009** |
| wNAO | 21.78 | **<0.001** | 39.88 | **<0.001** |
| Lat (Log10) | 15.27 | **<0.001** | 28.84 | **<0.001** |
| Long (Log10) | 33.13 | **<0.001** | 17.76 | **<0.001** |
| D\_Colony (Log10) | 19.66 | **<0.001** | 2.41 | 0.123 |
| Depth (Log10) | 7.81 | **0.006** | 24.32 | **<0.001** |
| SST (Log10) | 0.89 | 0.347 | 0.71 | 0.402 |
| Chl a (Log10+1) | 5.74 | **0.018** | 4.15 | **0.044** |
| D\_ICoast (Log10+1) | 2.16 | 0.145 | 1.03 | 0.312 |
| D\_River (Log10) | 9.87 | **0.002** | 5.01 | **0.027** |
| D\_Canyon (Log10) | 1.23 | 0.269 | 1.71 | 0.194 |
| Year | 9.59 | **<0.001** | 19.24 | **<0.001** |
| Stage | 3.47 | **0.034** | 0.91 | 0.406 |
| Month | 23.60 | **<0.001** | 39.12 | **<0.001** |

**Supplementary Table 7.** Mixed-effects ANOVA model for the effect of explanatory variables in δ13C and δ15N values, for of the 49 Cory’s shearwaters (*Calonectris borealis*) from Corvo Island, in 2010 and 2015. Bold terms indicate statistically significant effects. See Table 1 for a description of each explanatory variable. Note that some variables were log10 or log10+1 transformed to better fit the assumptions of the model (normally distributed variables and homoscedastic residuals).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | δ13C values | | δ15N values | |
|  | F | p | F | p |
| NAO | 60.38 | **<0.001** | 44.61 | **<0.001** |
| wNAO | 60.38 | **<0.001** | 44.61 | **<0.001** |
| Lat (Log10) | 32.71 | **<0.001** | 1.22 | 0.277 |
| Long (Log10) | 0.01 | 0.909 | 0.07 | 0.791 |
| D\_Colony (Log10) | 0.19 | 0.667 | 0.04 | 0.834 |
| Depth (Log10) | 1.22 | 0.277 | 0.19 | 0.665 |
| SST (Log10) | 0.43 | 0.516 | 0.23 | 0.635 |
| Chl a (Log10+1) | 0.05 | 0.829 | 0.29 | 0.591 |
| D\_Coast (Log10+1) | 0.87 | 0.358 | 1.28 | 0.264 |
| D\_ICoast (Log10+1) | 1.13 | 0.294 | 3.89 | 0.056 |
| Year | 5.67 | **0.022** | 18.39 | **<0.001** |

**Supplementary Table 8.** Mixed-effects ANOVA model for the effect of explanatory variables in δ13C and δ15N values, for the neritic environment at a local scale (i.e. <100 km from the colony) of the 90 Cory’s shearwaters (*Calonectris borealis*) from Berlenga Island, between 2010 and 2015. Bold terms indicate statistically significant effects. See Table 1 for a description of each explanatory variable. Note that some variables were log10 or log10+1 transformed to better fit the assumptions of the model (normally distributed variables and homoscedastic residuals).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | δ13C values | | δ15N values | |
|  | F | p | F | p |
| NAO | 6.98 | **0.010** | 2.05 | 0.157 |
| wNAO | 62.25 | **<0.001** | 73.90 | **<0.001** |
| Lat (Log10) | 13.22 | **<0.001** | 1.78 | 0.186 |
| Long (Log10) | 35.01 | **<0.001** | 52.95 | **<0.001** |
| D\_Colony (Log10) | 4.48 | **0.038** | 0.28 | 0.599 |
| Depth (Log10) | 3.13 | 0.081 | 1.59 | 0.212 |
| SST (Log10) | 8.46 | **0.005** | 7.81 | **0.007** |
| Chl a (Log10+1) | 2.54 | 0.116 | 1.43 | 0.236 |
| D\_ICoast (Log10+1) | 1.01 | 0.319 | 1.12 | 0.293 |
| D\_River (Log10) | 2.48 | 0.120 | 0.25 | 0.620 |
| D\_Canyon (Log10) | 0.71 | 0.401 | 4.32 | **0.041** |
| Year | 14.27 | **<0.001** | 25.79 | **<0.001** |
| Stage | 3.25 | **0.045** | 0.41 | 0.667 |
| Month | 2.46 | 0.122 | 17.36 | **<0.001** |

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**Supplementary Figure 1.** Graphs showing the relationships between both isotopic values and explanatory variables (some were log10 or log10+1 transformed for better visualization) used in the random forest model for the pooled data, i.e. the 191 Cory’s shearwaters (*Calonectris borealis*) from Berlenga and Corvo Islands, between 2010 and 2015. See Table 1 for a description of each explanatory variable.

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**Supplementary Figure 2.** Graphs showing the relationships between both isotopic values and explanatory variables (some were log10 or log10+1 transformed for better visualization) used in the random forest model for the neritic environment of the 142 Cory’s shearwaters (*Calonectris borealis*) from Berlenga Island, between 2010 and 2015. See Table 1 for a description of each explanatory variable.

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**Supplementary Figure 3.** Graphs showing the relationships between both isotopic values and explanatory variables (some were log10 or log10+1 transformed for better visualization) used in the random forest model for the oceanic environment of the 49 Cory’s shearwaters (*Calonectris borealis*) from Corvo Island, in 2010 and 2015. See Table 1 for a description of each explanatory variable.

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**Supplementary Figure 4.** Graphs showing the relationships between both isotopic values and explanatory variables (some were log10 or log10+1 transformed for better visualization) used in the random forest model for the neritic environment at a local scale (i.e. <100 km from the colony) of the 90 Cory’s shearwaters (*Calonectris borealis*) from Berlenga Island, between 2010 and 2015. See Table 1 for a description of each explanatory variable.